What Is Claimed Is:

1) A device for igniting an air-fuel mixture in an internal combustion engine using a high-frequency electrical power source, having

- a coaxial waveguide structure (5) into which the high-frequency electrical power may be coupled in and whose one end protrudes into the individual combustion chamber of a cylinder of the internal combustion engine, a microwave plasma being generatable at this end via a high voltage potential,

wherein

- the one end of the coaxial waveguide structure (5) is designed as an igniter (7a) in such a way that, when a voltage potential is applied, a free-standing plasma is generatable in the air-fuel mixture at the inner conductor (7, 7a) of the waveguide structure (5), which projects from the waveguide structure by a predefined amount, via a field structure (22) protruding into the combustion chamber.

2) The device as recited in Claim 1,
wherein

- the coaxial waveguide structure (5) is designed in such a way that, for a predefined effective wavelength (λ_{eff}) of the coupled-in high-frequency oscillation, a cavity resonator results approximately according to the formula $(2n+1) * \lambda_{eff}/4$ with $n \geq 0$ and the high-frequency oscillation may be coupled in via a capacitive, inductive, mixed, or aperture coupling.

3) The device as recited in Claim 1 or Claim 2,
wherein

- the one end of the coaxial waveguide structure (5) in the combustion chamber includes a seal (20) made of dielectric material between the outer conductor (6) and the coaxial inner conductor (7), the seal being provided

with at least one abrupt and/or smooth cross-section change (21) in the axial direction, resulting in an optimal field structure (22) for generating a free-standing plasma.

4) The device as recited in Claim 3,
wherein

- the seal (20) is mounted in a recess of the outer conductor (6) which has an abrupt cross-section enlargement (21) toward the one end.

5) The device as recited in Claim 3 or Claim 4,
wherein,

- in the area of the one end of the waveguide structure (5), the cross section of the inner contour of the outer conductor (6) and the cross section of the outer contour of the inner conductor (7) is abruptly and/or smoothly changed in predefined areas in an appropriate manner.

6) The device as recited in one of the preceding claims,
wherein

- an electrical signal, which is a function of the physical variables of the free-standing plasma in the air-fuel mixture, may be decoupled at the oscillator (2; 32) or at the coaxial waveguide (5).

7) The device as recited in Claim 6,
wherein

- the decoupled electrical signal may be further processed in an analyzing circuit by which a device diagnosis, a regulation of the high-frequency power source, and/or a control of predefined operating functions may be effected.

8) The device as recited in one of the preceding claims,
wherein

- a compact ignition unit (30) is formed which has a free-

running oscillator circuit (32), additional components (31, 33), and the coaxial waveguide (5) in a common housing.

9) The device as recited in Claim 8,
wherein

- an amplifying circuit (3) is downstream of the free-running oscillator circuit (2; 32).

10) The device as recited in Claim 7 or Claim 8,
wherein

- the free-running oscillator circuit (2; 32) and/or the downstream amplifying circuit (3) is/are designed as an integrated semiconductor circuit using SiC or GaN components.